REMARKS/ARGUMENTS

By this Amendment, Claim 6 is amended. Claims 1, 2, 5-9 and 15 are pending.

Favorable reconsideration is respectfully requested in view of the foregoing amendments and the following remarks.

REJECTIONS UNDER 35 U.S.C. § 103:

Background

Aircraft braking systems generally comprise a stack of alternating stator discs and rotor discs. Typically, the stator discs are coupled to a torque tube which is fixed with respect to the airframe, while the rotor discs are coupled to a wheel assembly which is rotatably mounted to the airframe. The arrangement further includes a means for compressing the stack, thereby to reduce the angular speed of the rotor discs and wheel assembly to slow the aircraft.

This invention relates to a composite article which exhibits low wear and which has a high heat capacity. Particularly, the invention relates to a carbon friction disc for use in an aircraft brake.

As background it is noted that the density of C-C is less than 1.85 gcm^{-3}, and that the density of Si-C is 3.22 gcm^{-3}. Moreover, if a porous body is infiltrated with another species, it will inevitably have a density higher than that of the unimpregnated body.

In the field of aircraft brakes, indeed in any of the aviation fields, it is a common goal to increase efficiency by decreasing the weight of component parts. The Applicant has succeeded in decreasing the weight of a brake assembly and he has done so in an inventive manner. Rather than simply decreasing the weight of some or all of the component parts, the Applicant has

reduced the size of one of the largest but most essential components of a brake assembly - the brake disc.

The inventive brake disc itself could be lighter than a standard brake disc, though it could also be heavier or of a similar weight. The significant reductions in the weight of the brake assembly are found in the corresponding reductions in size of the other components of the brake assembly.

All this is achieved without a corresponding loss of performance because the Applicant had the ingenuity to turn a long accepted practice on its head. As will be demonstrated below, refractory carbides have long been regarded as the most suitable materials to use at the friction faces of aircraft (and other) brake discs, owing to its excellent friction characteristics and heat-sink properties. Certainly, the use of refractory carbides is considered superior to the use of ordinary carbon composite materials.

Rather than following the well-trodden path, the Applicant designed a new and inventive brake disc of reduced axial dimension by forming a core portion of refractory carbide impregnated carbon composite, and attaching wear layers have a lower density than the core layers, therefore a lower density of refractory carbide or even no refractory carbide at all.

REJECTIONS UNDER 35 U.S.C. § 103(a):

The Examiner first rejected Claims 1, 2 15 under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,057,022 (Purdy) in view of U.S. Patent No. 3,897,582 (Olcott) or EP 1 260 729 (Johnson). This rejection is traversed for the reasons that follow.

Rejection of Independent Claim 1

Independent Claim 1 recites an aircraft brake heat pack brake disc in the form of a composite article comprising a core layer having a face portion and wear layer attached to the face portion, wherein the core layer is a c-c composite article impregnated with a refractory carbide and the wear layer has a density lower than the core layer. The Examiner has rejected Claim 1 under Section 103(a) as obvious over Purdy in view of Olcott or Johnson.

Limitations of Purdy

The Examiner states at paragraph 2 of her final rejection that Purdy teaches all limitations of the claimed invention except wherein the core layer is a C-C composite article impregnated with refractory carbide. The Applicant has consistently rebutted the Examiner's position in this regard, yet the Examiner has continued to insist that Figures 8-13 and column 8 of Purdy describe all features of the Claim except that described above. The Applicant shall examine each and every feature of the Claim that the Examiner perceives to be present in Purdy.

First, the Applicant maintains that Purdy does not describe a composite article comprising a core layer having a face portion and a wear layer attached to the face portion. A patent claim is to be interpreted by a person having ordinary skill in the art in question. It is clear from the language of the Claim that such a skilled person would understand that the Claim requires a disc which is formed as a laminate of at least two separate elements: a core layer and a wear layer. A person having ordinary skill in the art, recognizes this because of the requirement that the core layer has a face to which the wear layer is attached.

For the core layer to have a "face", it must have had, at some stage in its existence, an

exposed surface (a coal face, for example, is not a coal face until it is exposed by mining). This necessity is inseparable from the requirement that Claim 1 recites a laminate article of two once-separate layers.

Furthermore, the recitation in Claim 1 that the wear layer is attached to the face of the core layer, with all of the connotation of bringing two articles together brought by the verb "to attach," also makes clear that the core layer and wear layer are separate articles now joined together.

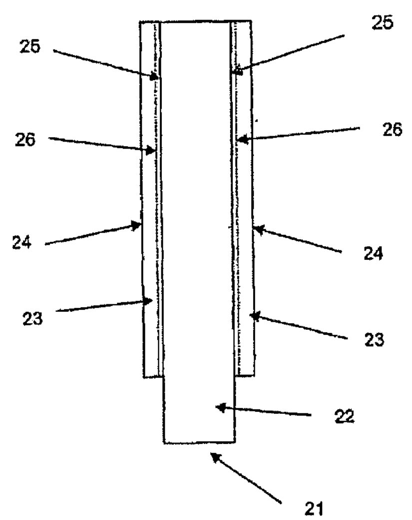


Figure 2

Should the person having ordinary skill in the art be in any doubt as to the laminate structure of the article recited in Claim 1, we need only turn to Figure 2 of the application in suit, as shown above, where defined and separate core (22) and wear (23) layers are clearly shown. The skilled person knows that a wear face of a brake disc is an annular body which abuts, during a braking operation, and annular wear face of an adjacent disc. No other interpretation is possible.

Turning now to Purdy, the Applicant maintains that there is no evidence of the creation of a laminate structure. The Examiner refers specifically to column 8 and to Figures 8-13, which show and describe composite articles and also describe their manufacturing methods. The articles each have a density which varies across their cross-section owing to their method of manufacture, displayed in the Figures by regions of contrasted shading. The articles are shaped as might be aircraft brake discs, having a circumferential surface 84, an inside circumferential surface 82, and planar surfaces 78 and 80.

The Applicant respectfully submits that not one of the articles displayed in Figures 8-13 of Purdy is a laminate article and that the text of column 8 of Purdy describes neither the attachment of two or more layers, nor a ready made laminate. Instead, Purdy describes the manufacture of composite <u>unitary</u> articles having variable density, as a result of a pressure gradient that causes

> the reactant gas .... to crack and preferentially deposit matrix within the portions of the porous structure subjected to a pressure relatively greater than the pressure in other portions

(col. 8, lines 18-21)

during a matrix deposition process.

The Examiner is of the opinion that the areas of similar density shown in each of the articles in Figures 8-13 of Purdy are analogous to the core layer and the wear layer as recited in the presently pending Claim 1, then for the reasons described above, the Applicant ardently contests this opinion.

Moreover, the presently pending Claim 1 also requires that the wear layer has a density

lower than the core layer. Leaving aside any debate over the presence or otherwise of discrete, and previously separate, "layers," the Applicant submits that this requirement is not even suggested in the teaching of Purdy. Turning again to Figures 8-13, the Applicant sees a number of cross-sectional representations of articles, at least broadly suitable for use as aircraft brake discs, having varying internal densities marked by areas of contrasted shading. At column 8, lines 25-26, Purdy informs us that:

> finely crosshatched areas represent greater density relative to coarsely cross-hatched areas.

The Applicant feels that it is important to note, for the avoidance of doubt, that the "wear layer" of the present Claim 1, or at least a wear face thereof, would be positioned equivalent to one or both of the "opposing surfaces 78,80" of Purdy, as opposed to the "circumferential surface 84", of, for example, Figure 9.

The Applicant submits that only two of the articles shown in Figures 8-13, Figures 9 and 13, could be purported to show what might be described as a "wear section" and a "core section" having differing densities in the present context. Both Figure 9 and figure 13 show articles where most of the wear section (opposing surfaces 78, 80) has the same density, in contrast to Figures 8 and 10-12. Furthermore, the core section of Figures 9 and 13 is clearly of a different density to the wear section as the more central regions of the articles displayed in each carry a different shading. However, it is abundantly clear that the density of the wear section is greater than that of the core section, as demonstrated by the finer cross-hatching. The applicant submits that this plainly teaches away from the requirement that the wear layer be of a lower density than

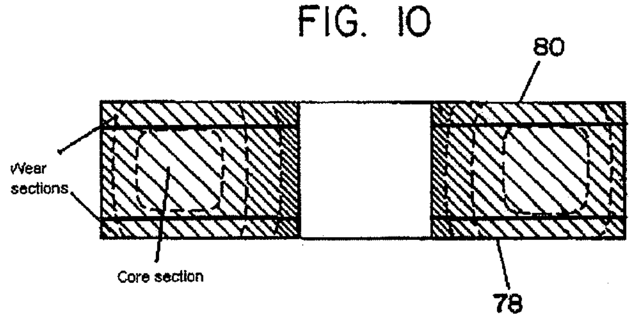
the core layer. Meanwhile, Purdy himself describes the disc of Figure 8 as

"unacceptable for many applications"

(Purdy, column 8, lines 39 to 41),

perhaps because the density gradient is not symmetrical through the thickness of the structure, such symmetry described as being desirable for brake disc applications (Purdy, column 8 lines 62 to 64). With reference to Figures 10 to 12, the Applicant submits that even if the opposing surfaces 78,80 were to be described as wear sections, despite the uneven density distribution (as shown in the annotated Figure 10 of Purdy, below), all have regions of lowest density within the core section, and thus the wear sections have a greater average density. This, again, is in direct contrast to the recitations of Claim 1 of the application in suit.

FIG. 10



The Examiner has stated that Purdy lacks disclosure of only one feature of Claim 1 - that the core layer is a C-C composite article impregnated with a refractory carbide. The Applicant, however, has unambiguously shown that Purdy further lacks in teaching 2 other essential features recited in Claim 1:

(i) that the heat pack brake disc be in the form of a composite article comprising a core layer having a face portion and a wear layer attached to

the face portion;

(ii) that the core layer comprises a C-C composite article impregnated with a refractory carbide, and

(iii) that the wear layer have a density lower than the core layer.

In fact, Purdy teaches away from the last of these deficiencies. For a rejection under 35 U.S.C. § 103(a) to stand, the prior art must cure all of these deficiencies.

It is therefore asserted that the rejection of Claims 1, 2 15 under 35 U.S.C. § 103(a) as being unpatentable over Purdy in view of Olcott or Johnson be withdrawn and these Claims passed to allowance.

Purdy in view of Johnson or Olcott

The Examiner states that the somewhat substantial deficiencies in the teaching of Purdy are satisfied by Johnson or Olcott to constitute a rejection under § 103(a). The Applicant submits that this is not the case, as neither Johnson nor Olcott provide an aircraft brake disc with a wear layer having a lower density than the core layer.

In her own words, the Examiner claims that

> it would have been obvious ... to impregnate a C-C wear layer with a refractory carbide to improve the adhesion characteristics of wear layers and to provided (sic) improved heat sink capabilities for use in making friction materials.

(emphasis added).

Whether or not the Examiner is correct in her assertion is of no consequence, as this construction does not lead to the presently pending Claim 1. In contrast, Claim 1 of

the application in suit requires only the core layer to be impregnated with refractory carbide. The wear layer is required only to be of a lower density. Moreover, even if the Examiner erred in describing the wear layer of the claimed invention, rather than the core layer as a C-C composite impregnated with refractory carbide, neither Johnson nor Olcott provide the features of the invention in suit not disclosed by Purdy.

Johnson discloses methods of forming a composite article comprising a carbon matrix containing refractory carbide particles. Such articles comprise a carbon matrix containing, within its interior, refractory carbide particles, which are substantially individually encapsulated within deposited carbon.

In relation to brake discs, Johnson teaches one skilled in the art that the radial density of a disc may be non-uniform in order to facilitate machinability in certain regions. There is no teaching of altering the axial density so as to provide a less dense wear layer. Moreover, Johnson describes, at paragraph [0009], that it

> is desirable to combine the friction properties of [a] refractory carbide carbon-carbon composite with the machinability of C-C.

This statement asserts that refractory carbide, owing to its excellent frictional performance, is indispensable at the frictional face of a brake disc, teaching away from the requirements of Claim 1 of the application in suit.

Olcott teaches C-C braking elements for aircraft and, like Johnson, extols the use of embedded refractory carbides in the <u>wear</u> surface. Olcott teaches that embedded refractory carbides "substantially increase oxidation resistance" (column 2, line 56) and "provide improved heat sink capabilities and frictional resistance properties" (column 2, lines 62~63). Furthermore,

Olcott goes on to say that the

> improved heat sink properties of the microcomposite reduce frictional interface temperatures and resulting thermal stresses, thereby reducing fracturing and erosion of the carbon braking element."

(column 4, lines 13-16).

The above teachings made by Olcott undoubtedly highlight the excellent heat sink properties of C~C composites impregnated with refractory carbides. Furthermore, the Applicant does not hide that this characteristic is very successfully exploited by the invention as claimed. However, the applicant submits that Olcott does not bring one having ordinary skill in the art to the invention recited in Claim 1 from the teaching of Purdy. Besides the lack of a teaching of a core layer having a higher density than a wear layer (which, despite the Examiner's protestation, would be necessary for a successful § 103(a) rejection, as it is, for the reasons described above, not described in Purdy), Olcott teaches away from the presently claimed invention. Olcott's descriptions of the effectiveness of refractory carbide impregnated composites as frictional surfaces for brakes (as described above) point one having ordinary skill in the art to use such a composite as a wear layer. Consequently, in order to reduce the weight of the brake disc, as is required for efficiency savings, one having ordinary skill in the art would make the core layer from a less dense material, such that the overall weight of the brake disc could be kept low. The Examiner appears to have failed to appreciate that the invention as claimed in the presently pending Claim 1 is exactly the opposite of this.

As the Applicant has demonstrated herein, none of Purdy or Johnson or Olcott, either

alone or in combination, teach all of the limitations of the present Claim 1. On the contrary, together the references lead the reader to something quite different. The Applicant therefore submits that the rejection of Claim 1 under §103(a) as being unpatentable over Purdy, in view of Johnson or Olcott is unsustainable. It is therefore respectfully requested that the Examiner withdraw the rejection to Claim 1 and pass Claim 1 to allowance.

Rejection of Dependent Claim 2

The Examiner also rejected Claim 2 as unpatentable under §103(a) over Purdy in view of Olcott or Johnson. The present Claim 2 incorporates all of the features of the present Claim 1, further reciting that the core layer have a density in excess of 1.85 gcm^{-3}.

The Applicant submits that, for the reasons described above, none of the cited references disclose or suggest, either alone or in combination, all of the features of the present Claim 1, the rejection of Claim 2 under § 103(a) as unpatentable over Purdy in view of Olcott or Johnson is unsustainable. It is therefore respectfully requested that the Examiner withdraw the rejection to Claim 2 to and pass Claim 2 to allowance.

Rejection of Independent Claim 15

Independent Claim 15 recites an aircraft wheel and brake assembly comprising brake discs, one or more of the brake discs having a core layer of density greater than 1.85 gcm^{-3} and at least one wear layer attached to the core of density 1.85 gcm^{-3} or lower, wherein the core layer comprises a C-C composite impregnated with refractory carbide.

The aircraft wheel and brake assembly recited in independent Claim 15 clearly requires a brake disc of similar scope to that recited in dependent Claim 2. It is plain that the Claim requires that the core layer is required to have a density higher than the wear layer, as the core layer is required to have a density greater than 1.85gcm^{-3} or lower.

As the Applicant discussed in relation to Claims 1 and 2, such an arrangement is not disclosed or suggested in any of Purdy, Olcott or Johnson, either alone or in combination, and as such the Examiner's rejection under § 103(a) is unsustainable. It is therefore respectfully requested that the Examiner withdraw the rejection to Claim 15 and pass Claim 15 to allowance.

The Examiner next rejected Claims 1, 2, 5-9 and 15 under 35 U.S.C. § 103(a) as being unpatentable over to U.S. Patent No. 6,042,935 (Krenkel) or U.S. Publication No. 2003/0057040 (Bauer) or U.S. Patent No. 6,221,475 (Domergue et al.) or US 2002/0068164 (Martin), in view of GB 2 298 687 (Fennell) or U.S. Patent No. 6,057,022 (Purdy) or U.S. Patent No. 6,079,525 (Dietrich) and further in view of U.S. Patent No. 3,897,582 (Olcott and EP 1260729 (Johnson). This rejection is traversed for the reasons that follow.

Rejection of Independent Claim 1

As described above, the heat pack brake disc recited in Claim 1 is required to have a core layer being a C-C composite article impregnated with a refractory carbide and a wear layer having a density lower than the core layer. The Examiner has rejected Claim 1 under §103(a) as obvious over Krenkel or Bauer or Domergue or Martin in view of Fennell or Purdy or Dietrich and further in view of Johnson or Olcott.

Limitations of Krenkel

Krenkel describes a composite brake disc, primarily for automobiles, which is made up of two friction bodies mounted upon a core body. Krenkel does not describe, however, his friction bodies as having a density lower than his core body.

Krenkel teaches us that both his friction body and his core body have been infiltrated with silicon and pyrolised - the required steps for silicon carbide impregnation (column 5, line 53 to column 6, line 17). Krenkel goes on to point out that his "bonding layer of Si-C is similar in nature to the Si-C filling the pores of the friction body and core body", implying, if not explicitly stating, that the friction and core bodies are made from the same material, and thus are of equal density.

When Krenkel does suggest potential differences in characteristics of the friction body and the core body, on the grounds that each can be optimized to its task, he describes a friction body having an "extremely dense material surface" as desirable (Krenkel at column 7, line 14). No such description is given to the core body, so the reader must assume that Krenkel prefers his friction body to be more dense than his core body. This is the opposite arrangement to that recited in the present Claim 1.

<u>Limitations of Bauer</u>

Bauer describes a composite brake disc having a mechanically strong core body, and a frictional body. Bauer does not describe the core body (or layer) as having a density greater than the frictional body (or layer). The brake disc described by Bauer is constructed from C-C and impregnated with Si-C. He teaches that the Si-C content of the friction body should be at least

65%, and more preferably between 80% and 99% (para. [0013]). The core body taught by Bauer is described as having a Si-C content of less than 65% (para. [0016]). Perhaps more crucially, paragraph [0016] also teaches that "the compositions of the C/Si-C are adjusted in the brake disc in such a way that the Si-C content of the support zone is less than that in the friction layer". In the absence of any explicit references to density, one having ordinary skill in the art will understand that the higher Si-C content of a composite article, the higher the density. Therefore, the clear teaching of Bauer is that the friction layer should be more dense than the core layer. Just as in Krenkel, this teaching is in complete contradiction to the invention as recited in Claim 1.

Limitations of Domergue

Domergue describes a C-C composite brake disc having a wear portion and a core. Domergue does not, however, describe a core having a greater density than a wear portion.

Si-C is described as particularly useful in friction components because of its increased coefficient of friction (Domergue at column 3, lines 31-32), wear reducing properties (Domergue at column 3, lines 52-53) and resistance to oxidation (Domergue at column 3, lines 59-60). Accordingly, Domergue teaches that the friction element has a "Si-C phase which need be present only over a limited depth starting from the, or each, friction face."
(column 3, lines 62-65).

In contrast, Domergue prefers to have no Si-C phase in the core of his brake disc: "the absence of a silicon carbide phase confers lower stiffness to the core and preserves good

mechanical behavior to the core of the disc" (column 4, lines 3-5). This teaching is reiterated at column 9, lines 26-30, where Domergue states: "the Si-C provides the desired qualities of hardness and resistance to wear, and also reduces the residual porosity in the wear portions, while the absence of Si-C, in at least a large portion of the core enhances both the heat sink effect and mechanical strength."

Once again, the Applicant submits that this teaching is the opposite of the recitations of Claim 1. In fact, not only does Domergue teach that the wear layers should be more dense than the core (note Domergue's references to "densification" when describing the Si-C impregnation steps), but he also proposes that there should be no refractory carbon in the core, also in contradiction to Claim 1.

Limitation of Martin

Martin describes a brake disc having a core layer and a friction layer, both layers being formed from silicon carbide reinforced by carbon fibers. Martin does not teach, however that the core layer is of greater density than the friction layer.

It is described by Martin that the core layer and the friction layer be "built up from similar material" (para. [0021]). The only difference the compositions of the friction layer and the core layer are that the supporting carbon fibers are shorter in the friction layer. This is described as being for the prevention of the excessive outbreaking that occurs with longer carbon fibers or without carbon fibers. No indication is given about the quantity or concentration of carbon fibers used in the friction or core bodies, such that an estimate of the relative densities

could be made. Therefore, the Applicant submits that the reader must assume that the densities of the friction and core bodies are not appreciably different.

General Comments on Principal References and Rejection

Before proceeding to examine the effect of the secondary references cited by the Examiner, the Applicant feels it prudent to comment on the teachings of the principal references, together with, and in view of, the final rejection made by the Examiner.

The Examiner states in paragraph 3 of her final rejection that "it would have been obvious to select the density of the core to wear layer in each of the principle references to be with the core density 1.85 gcm^{-3} to 2.95 gcm^{-3} and the wear layer(s) 1.85 gcm^{-3} or lower as taught by each of the secondary references to reduce weight and costs to compensate for the squeezed profit margins in business today by routine trial and error which leads to optimum ranges."

The Applicant submits that in this rejection the Examiner is merely extracting features from the references, without viewing the teachings of the references as a whole. The Applicant submits that the four principal references cited by the Examiner (and in particular Krenkel, Bauer and Domergue), when each is viewed as a whole, provide a very useful demonstration of the state of the art at the time that the invention was made. Together they actually highlight the significant contribution that the Applicant has made to the art.

All of Krenkel, Bauer, Domergue and Martin, as the Applicant has described, view the friction properties of refractory carbide impregnated C-C composite articles, and as such teach

their use at the friction faces of brake discs. Krenkel describes his frictional bodies as having an "extremely dense" surface and Bauer and Domergue both teach the use of bodies with relatively high Si-C at the friction faces (and accordingly, high density) and less or no refractory carbide in the core. The coefficient of friction and its response to temperature, the wear characteristics and the heat sink capabilities of Si-C impregnated C-C composites are, it seems, so well suited to the material's use at the friction faces of brake discs, that a person having ordinary skill in the art would consider Si-C impregnated wear faces prerequisite to making an effective brake disc. When this is added to, as it is by Domergue, in the teaching that lower density C-C composite, without an Si-C matrix, exhibits the excellent flexibility and mechanical strength required for a core layer, the use of high (or relatively high) Si-C content (and thus high density) in wear faces of aircraft brake discs is further supported. That even Martin, directing his teaching forward the considerably less demanding field of automobile brakes, teaches the use of Si-C at the friction surface, is quite clearly indicative that this technology is deeply ingrained in the art.

The Examiner's rejection refers to the need for reduction in weight and costs and states that this reduction could be achieved by a person having ordinary skill in the art by routine trial and error, with respect to the secondary references. The Applicant submits, however, based on the teachings of the cited art that the person having ordinary skill in the art is not free to depart from the explicitly required use of Si-C at the wear face without a clear invitation to do so. Instead, the person having ordinary skill in the art would be likely to look to reduce the mass of the components already described.

The effect of the principal references are thus two-fold. Firstly, the art must show a wear

layer less dense than a core layer. Secondly, the art must show that necessary braking efficiencies, heat sinking and wear characteristics may be obtained by using a lower (or indeed zero) Si-C component in the wear layer than the core layer, such that the strong teaching in the art that dense Si-C impregnated structures provide such high quality wear faces.

Krenkel or Bauer or Domergue or Martin in view of Fennell

Fennell teaches a composite brake disc with a "drive region" for attaching to a rotor or stator, and a "friction region" for applying the necessary frictional force. The drive region, which, if for no other reason than its not being a "wear layer," can be regarded as being within the scope of the "core layer" of the present Claim 1, is reinforced by carbon fibers, whereas the friction region (wear layer) is reinforced with a comparatively more dense carbon matrix. As is described at page 10 paragraph 3, "This leads to a final composite structure in which the overall composite density is less in the drive regions than in the friction regions." Fennell, then, clearly would not lead the person having ordinary skill in the art to contemplate an aircraft brake disc having a core layer having a greater density than the wear layer, because, just as in the principal references, the opposite is taught.

The applicant finds no references to Si-C or other refractory carbides in Fennell, and as such it is impossible for Fennell to reverse the strong teachings of the art of the high quality wear faces produced by Si-C.

Krenkel or Bauer or Domergue or Martin in view of Dietrich

Dietrich describes a brake unit comprising a C-C composite brake disc and brake lining. Both are impregnated with Si-C, though the brake lining has a lower Si-C component than the brake disc, and as such a lower density (column 1, lines 34-60). During a braking maneuver, the brake lining is made to tribologically interact with the brake disc (see Claim 1). The lower hardness of the lining compared to the disc, attributed to the lower Si-C content, results in a longer life of the brake unit (column 1, line 61 to column 2, line 2).

The Applicant is unsure as to the relevance of Dietrich to the presently pending Claim 1. Both the brake lining and the brake disc as taught by Dietrich are "wear sections" in the sense that they both undergo friction during a braking maneuver. Though one is denser than the other, there is no teaching that the higher or lower Si-C content provides better or worse braking characteristics. On the contrary, the document teaches that together the higher Si-C content disc and lower Si-C content linking exhibit a high coefficient of friction and lower wear (column 2, lines 28-37). The teaching of Dietrich is thus inseparable from the action between two C-C/Si-C composites of differing densities. Consequently, one having ordinary skill in the art finds nothing in Dietrich to take him from any of the principal references even toward the invention recited in Claim 1. Certainly, there is no disclosure of a brake disc having a core layer of greater density than its wear layer. Neither is there teaching of any improved braking characteristics of lower (or zero) Si-C content wear layers - in fact, it is clear that the low Si-C brake lining wears faster than the high Si-C brake disc, further supporting the picture painted of the state of the art by the principal references. This reinforces the principal references insofar that it is clear that Si-

C must be present at the wear face.

Krenkel or Bauer or Domergue or Martin in view of Purdy

The Applicant, having described the relationship that Purdy enjoys with the presently pending Claim 1 in detail above, simply reiterates his argument. The principal references lack teaching of a brake disc having core layer of greater density than its wear layer. The Applicant has shown that Purdy does not describe a "core layer" or "wear layer" according to Claim 1, teaching, as it does, a unitary structure. Furthermore, even allowing for this difference, the Applicant has also demonstrated that perceivable wear regions taught by Purdy have a greater density than perceivable core regions. Once again, this gives strength to the picture created by the principal references that the state of the art relies heavily on higher density wear regions.

Krenkel or Bauer or Domergue or Martin in view of Purdy or Fennell or Dietrich and further in view of Olcott or Johnson

The Applicant, having examined Olcott and Johnson in detail above, in relation to the Examiner's first rejection, simply emphasizes that neither disclose a brake disc having a core layer of greater density than its wear layer, as is missing from the teachings of all the principal and secondary references. The Applicant also takes notice that the Examiner states that she does not rely on Olcott or Johnson for such a teaching, but instead for showing the benefits of using refractory carbides in frictional braking elements because of, for instance their wear resistance, (paragraph 4, Office Communication mailed 13 June 2007). Remembering the skilled person's understanding of the principal references, the Applicant submits then, that neither Olcott nor

Johnson adds anything to the rejection, as all of the primary references use Si-C in their braking elements. Furthermore, the wear resistance of Si-C or other refractory carbides is largely irrelevant to the invention as claimed in Claim 1, as refractory carbide is only required in the core layer.

In summary, the Applicant submits that this rejection is unsustainable. In making the rejection, the Examiner appears to have grossly mischaracterized either the claimed invention or the cited art, or both. In fact, rather than showing the claimed invention to be obvious, the cited references highlight just how elegantly inventive the brake disc of Claim 1 is. The references, as described above, show an art having an entrenched reliance on having wear portions of relatively high density or high refractory carbide content. All of the evidence before the Examiner suggests that a person having ordinary skill in the art would likely look to make core regions less dense so as to lower the mass and/or size of the brake assembly. The Applicant, however, goes completely against the grain in his quest to reduce the weight of a brake assembly. Rather than relying on high density, high refractory carbide wear layers, he makes the wear layers less dense and supports them with the high density refractory carbide impregnated composite. In doing so, he creates a brake disc of comparable mass, efficiency and active life. Crucially, though, the Applicant's brake disc is smaller, allowing for smaller axles, bearings and other parts of the brake and wheel assembly, thus making overall weight savings.

Such an arrangement, as amply demonstrated herein, has not been disclosed or suggested in the art. The Applicant submits, then, that the present Claim 1 is unquestionably nonobvious over the prior art of record. It is therefore respectfully requested that the Examiner withdraw the

rejection to Claim 1 and pass Claim 1 to allowance.

Dependent Claims 2 and 5

Dependent Claims 2 and 5, incorporate each of the limitations of Claim 1. The Applicant therefore submits that the rejections made by the Examiner are unsustainable, and that Claims 2 and 5 are not obvious over Krenkel or Bauer or Domergue or Martin in view of Fennell or Purdy or Dietrich and further in view of Johnson or Olcott. It is therefore respectfully requested that the Examiner withdraw the rejection and pass Claims 2 and 5 to allowance.

Independent Claim 6

Presently amended independent Claim 6 recites an aircraft brake heat pack comprising a brake disc in the form of a composite article comprising a core layer formed from C-C composite impregnated with a refractory carbide, the core layer having a face portion to which is attached a refractory carbide free C-C wear layer having a density of 1.85 gcm^{-3} or lower.

As has been demonstrated in relation to independent Claim 1, the overwhelming teaching of the principal references cited by the Examiner, as understood by a person having ordinary skill in the art, is that it is imperative to use Si-C at the wear face of an aircraft brake disc in order to obtain optimal performance.

Claim 6 in suit requires exactly the opposite - that there be no refractory carbide in the wear layer (and thus at the wear face). As also described in relation to Claim 1 in suit, above, the secondary and tertiary references offer nothing to reverse the strong teaching of the principal

references, rather they reinforce it. As such, none of Krenkel, Bauer, Domergue, Martin, Dietrich, Fennel, Purdy, Johnson or Olcott, alone or in combination teach the limitations of Claim 6 as presently commended, and thus the Examiner's rejection under §103(a) is unsustainable.

<u>Dependent Claims 7 to 9</u>

The presently pending dependent Claims 7 to 9 are dependent upon, and include all the limitations of, independent Claim 6. As such, presently pending Claims 7 to 9 are not obvious over the prior art of record.

<u>Independent Claim 15</u>

Independent Claim 15, as previously described, recites an aircraft wheel and brake wheel assembly comprising brake discs, one or more of the brake discs having a core layer of density greater than 1.85 gcm^{-3} and at least one wear layer attached to the core of density gcm^{-3} or lower, wherein the core layer comprises a C-C composite impregnated with refractory carbide. What is clear from the reading of the Claim is that the recited brake disc has a refractory carbide impregnating core of greater density than its wear layer. As the Applicant has shown, none of Krenkel or Bauer or Domergue or Martin, in view of Fennell or Purdy or Dietrich, and further in view of Olcott or Johnson, alone in combination, teach such a brake disc. On the contrary, the clear consensus in the art cited is that it is preferable to use higher density, and/or higher refractory carbide content material at the wear layer making the core layer less dense, more

flexible and of greater mechanical strength. This is the opposite to the requirements of Claim 15, and thus the teachings of the cited art amply demonstrate the significant inventive contribution made to the art by the Applicant. The Examiner's rejection of Claim 15 under §103(a) is thus unsustainable.

Conclusions

The Applicant has clearly demonstrated above that the invention as claimed in Claims 1, 2, 5 to 9 and 15 is inventive over the prior art. The inventive leap taken by the inventor is in no way trivial because of the counter intuitive nature of constructing a brake disc with a greater degree of refractory carbide impregnation in a core portion than in the wear layers, in direct contravention to the teachings of the prior art.

Therefore, it is asserted that the rejection of Claims 1, 2, 5-9 and 15 should be withdrawn and these Claims should be passed to allowance.

For at least the reasons set forth above, it is respectfully submitted that all of the rejections have been overcome and the above-identified application, as amended, is in condition for allowance. Favorable reconsideration and prompt allowance of Claims 1,2 5-9 and 15 are respectfully requested.

Should the Examiner believe that anything further is desirable in order to place the application in even better condition for allowance, the Examiner is invited to contact Applicant's undersigned attorney at the telephone number listed below.

Respectfully submitted,

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October 26, 2007

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Please charge or credit our Account No. 03-0075 as necessary to effect entry and/or ensure consideration of this submission.